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System And Methods For Invalidation To Enable
Caching Of Dynamically Generated Content
Inventors: Wen-Syan Li et al.
Attorney: Ronald Coslick – 073303-0118
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Japan

1-2

1-1

End User
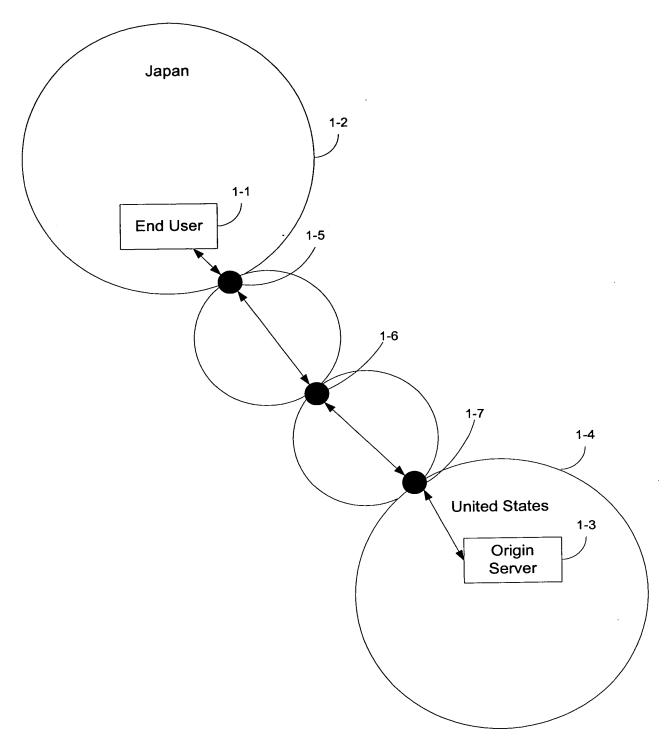
1-5

1-6

1-7

1-4

United States

1-3

Origin
Server

Figure 1

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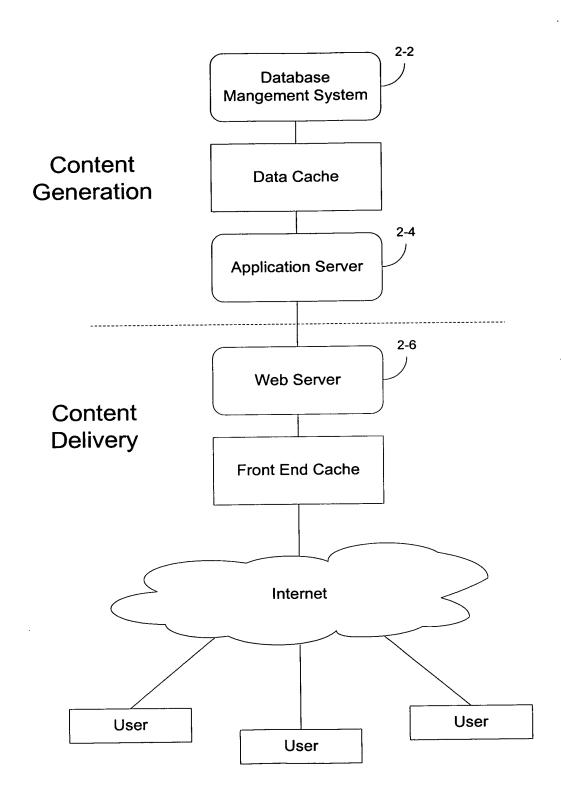FOLEY & LARDNER – (310) 277-2223
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Figure 2

Content
Generation

Content
Delivery

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Figure 3

$$Data \longleftrightarrow Queries \longleftrightarrow Content$$

Figure 4

Determine database changes $\quad$ 4-2

$\downarrow$

Determine queries to be invalidated from the database changes $\quad$ 4-4

$\downarrow$

Determine cached content related to the queries $\quad$ 4-6

$\downarrow$

Send invalidation messages to caches or web servers that contain the content $\quad$ 4-8

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System And Methods For Invalidation To Enable
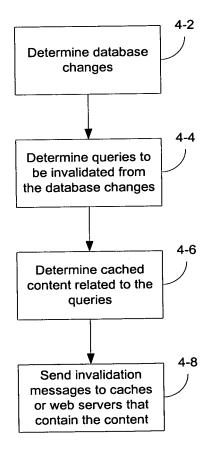Caching Of Dynamically Generated Content
Inventors: Wen-Syan Li et al.
Attorney: Ronald Coslick – 073303-0118
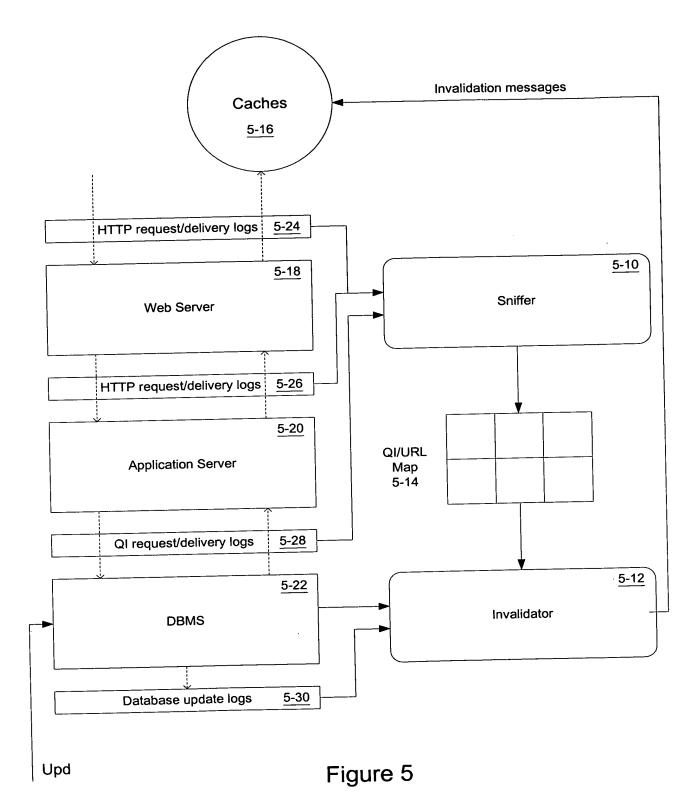FOLEY & LARDNER – (310) 277-2223
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Caches

5-16

Invalidation messages

HTTP request/delivery logs | 5-24

Web Server | 5-18

Sniffer | 5-10

HTTP request/delivery logs | 5-26

Application Server | 5-20

QI/URL
Map
5-14

QI request/delivery logs | 5-28

DBMS | 5-22

Invalidator | 5-12

Database update logs | 5-30

Upd
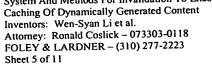
Figure 5

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Figure 6

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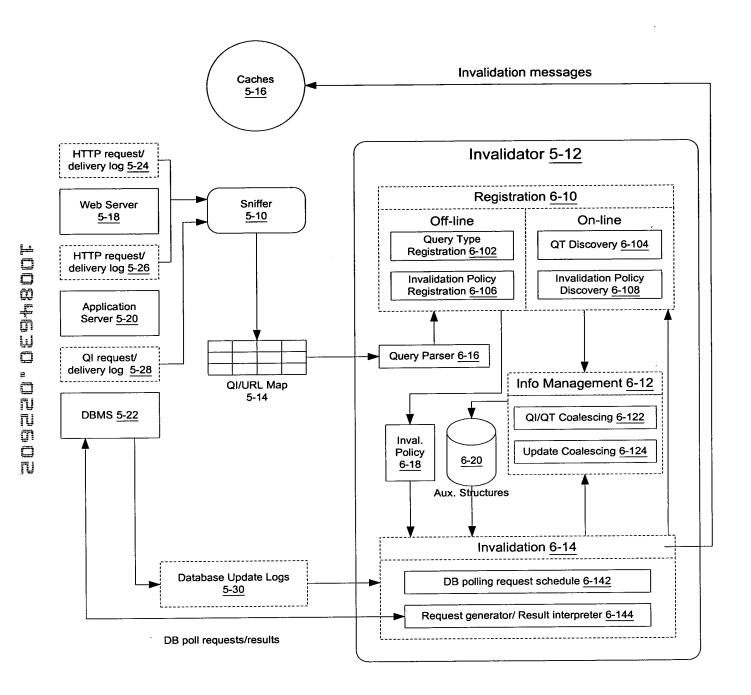Caching Of Dynamically Generated Content
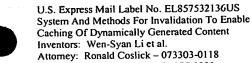Inventors: Wen-Syan Li et al.
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7-1

7-3

```
select *
from R2
where R2.b >50
```

```
select *
from R1
where R1.a < 100
```

```
select *
from R1, R2
where R1.a > R2.a
```

```
select *
from R1, R3
where R1.c = R3.c
```

7-2

7-4

```
select *
from R1, R2
where    R1.a > R2.a and
         R1.a < 100 and
         R2.b >50
```

```
select *
from R1, R2, R3
where    R1.a > R2.a and
         R1.c = R3.c
```

7-5

```
select *
from R1, R2, R3
where    R1.a > R2.a and
         R1.a < 100 and
         R1.c = R3.c
```

Figure 7

8-1

8-3

```
select *
from R2
where R2.b >50
```

```
select *
from R1
where R1.a < 100
```

```
select *
from R1, R2
where R1.a > R2.a
```

```
select *
from R1, R3
where R1.c = R3.c
```

8-2

8-4

```
select *
from R1, R2
where    R1.a > R2.a or
         R1.a < 100 or
         R2.b >50
```

```
select *
from R1, R2, R3
where    R1.a > R2.a or
         R1.c = R3.c
```

8-5

```
select *
from R1, R2, R3
where    R1.a > R2.a or
         R1.a < 100 or
         R1.c = R3.c
```
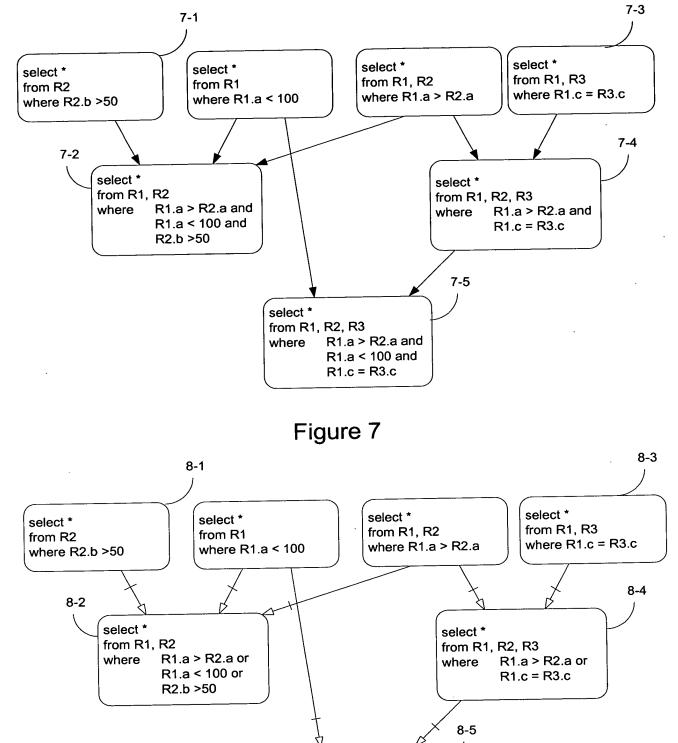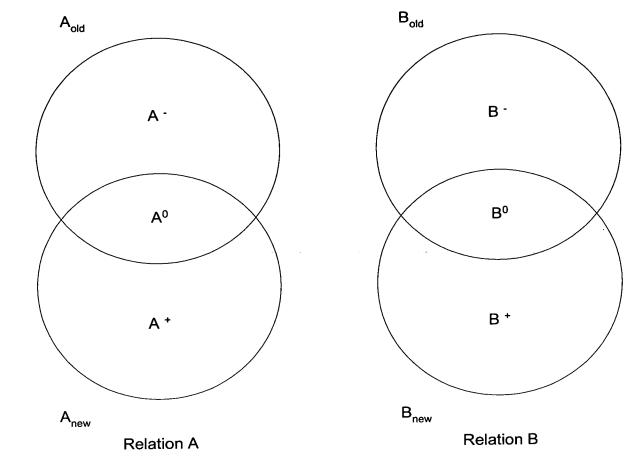
Figure 8

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Figure 9

t_0

t_1

Updates

Invalidator

Invalidate using
update log and DB2 t_0

Invalidate using
update log and DB2 t_1

DB1

Update Normally

DB2

Update from log to
reflect contents of
DB1 t_{-1}

No updates

Update from log to
reflect contents of
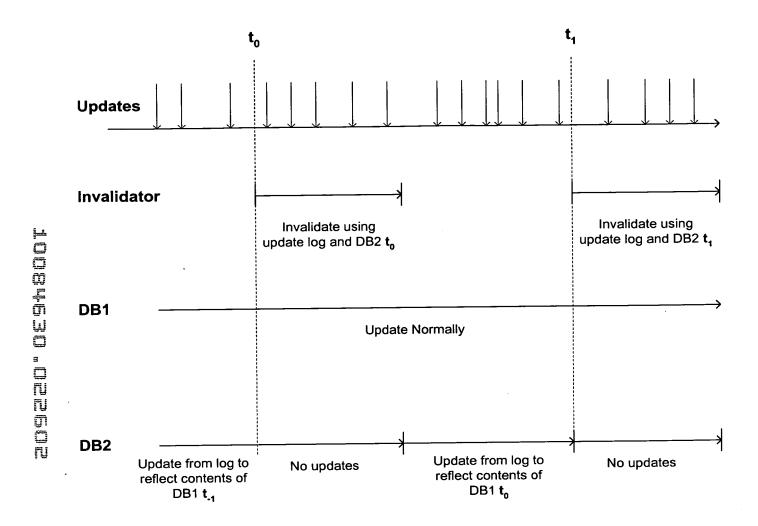DB1 t_0

No updates

Figure 10

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t_0 t_1

Updates

Invalidator

Invalidate using DB t_0
and update log

Invalidate using DB t_1
and update log

DB

Process all queued
updates and then
update normally

Updates are
queued

Process all queued
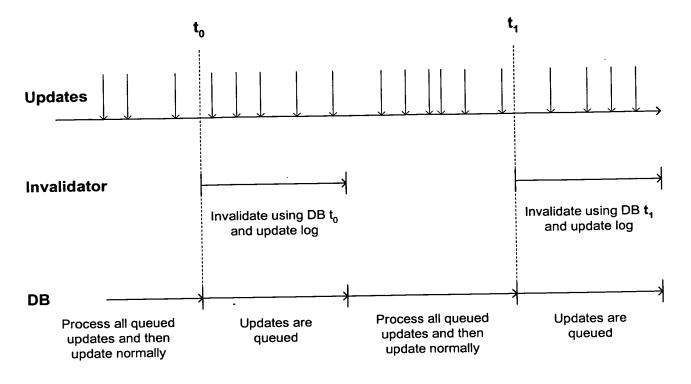updates and then
update normally

Updates are
queued

Figure 11

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Relation A

A'

Ag

Ad

Af

Ac

Ae

Aa

Ab

A_{old}

A_{new}

Relation B
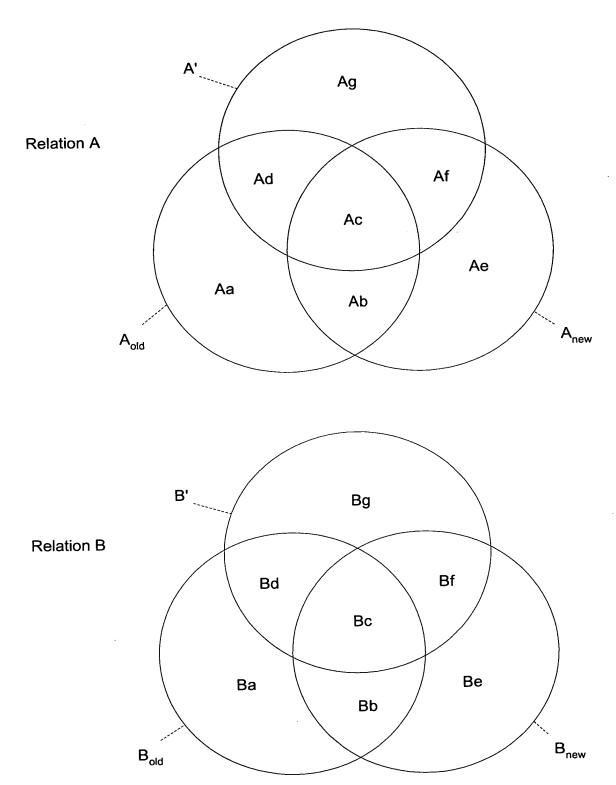
B'

Bg

Bd

Bf

Bc

Ba

Be

Bb

B_{old}

B_{new}

Figure 12

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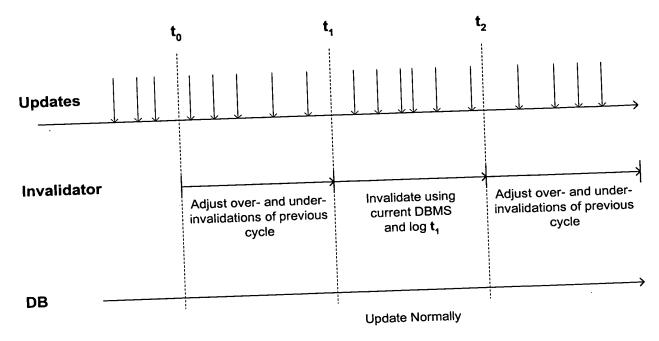FOLEY & LARDNER – (310) 277-2223
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t_0 t_1 t_2

Updates

Invalidator

| Adjust over- and under- invalidations of previous cycle | Invalidate using current DBMS and log t_1 | Adjust over- and under- invalidations of previous cycle |

DB

Update Normally

Figure 13